

IRAT APPROACH TO DEVELOPMENT OF INTENSIVE SYSTEMS IN PEASANT AGRICULTURE

A Case Study in Senegal

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The aim of this paper is to review the approach followed by IRAT in Senegal to development and introduction into the rural sector of production systems likely to change traditional agriculture without questioning the fundamental values of the rural community. Therefore, it only outlines the research methods and organization which enable the agronomists to reach already intensive technologies in an area where conditions are not very favorable.

In this paper, the attention is focused more on the ways of communicating with the farmer with a view to formulating his farm development plans which must indicate his land potentialities; use his means to best advantage and take account of his constraints; respect his ideas and attitudes; take account of the national objectives and realities; and define as far as possible the elements of an agricultural policy complying with these different conditions and constraints.

This paper is more a working document to be used as a basis for discussion than a true review document of the work and results obtained in Senegal, but its scope can probably be extended to cover a large part of the West African semi-arid area.

The Natural Environment

The physical environment of the Sudan-Sahelian zone of West Africa is characterized by:

A severe climate

- two contrasted seasons

- . a 7-9 months dry season
- . a 3-5 months wet season

- high temperatures
 - . annual mean : 27-28°C
 - . minimum-maximum mean : 20 and 35°C
- rainfall varying from 300 to 1,200 mm, with irregular distribution, often torrential or aggressive causing problems of serious erosion and runoff
- exceptional sunshine (always exceeding 200 days) resulting in a high potential plant photosynthesis
- high potential evapotranspiration (PET) varying from 4 to 6 mm by day in the wet season and 7 to 9 mm in dry season at peak times of drought.

Generally poor soils

- sandy to sandy-clay in the uplands, with very unfavorable structure and poor fertility.
- often high clay content, and low fertility in the lowland soils.

Traditional Agriculture

The 'traditional' agricultural systems are characterized by the often excessive exploitation of two factors from which any wealth springs, the land and labor, the part played by capital being generally very small. The other features of these systems are as follows:

- (i) Cultivation, which was first extensive, and semi-shifting, has become more and more permanent as the density of population increased and system of fallowing disappeared
- (ii) Hand cultivation prevails though animal drawn cultivation comes into rather general use for few small operations (sowing and hoeing); this leads to a lack of balance at the farm level which prevents actual increase in productivity owing to an always inadequate mechanization rate (0 to 30%)
- (iii) Inputs are low and even absent
- (iv) Labor organization is generally poor in the farm divided into sub-units, autonomous for the commercial crops, depending on the farm manager for the food crops
- (v) Labor exchanges, more particularly, depend largely on old social habits, are not adapted to the requirements of technological progress, both as regards their quality, quantity and distribution

- (vi) At the farm level the division into sub-units and the superposition of some technical innovations on old practices result in different systems existing simultaneously and more or less well specified in concentric areas from the farm center.

These characteristics involve or imply

- (i) inadequate clearing;
- (ii) extensive cultivation and low technical level, surface tillage, low amount of organic matter returned to the soil and inadequate weed control;
- (iii) small cultivated area per worker generally not exceeding 1 to 2 ha; and
- (iv) very limited use of fertilizers and pesticides.

This leads to

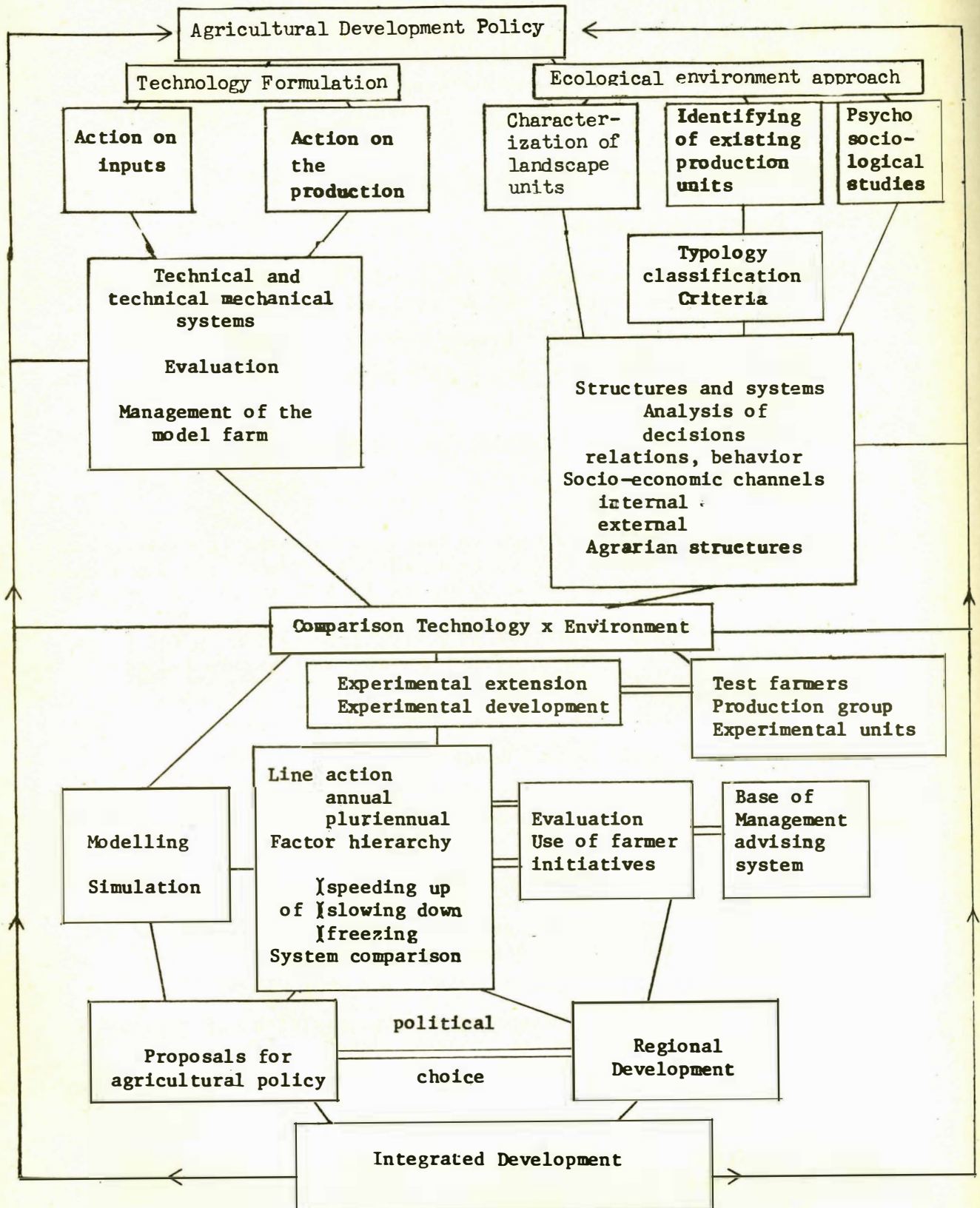
- (i) a reduced possible action on the environmental conditions and therefore a great difficulty in diversifying crops, low income per caput ranging from \$ 60 to 100 to \$ 80 to 140 per worker.
- (ii) very low labor efficiency (A worker devotes 700 to 900 hours/year to agricultural work and one man-hour yields 1-2 kg of produce-cereals or groundnut).

Technical Results of Agricultural Research

Technical improvements are being attempted mainly in the following fields:

- (i) the farmer's mechanical equipment, the options being generally but not exclusively: ox-draught cultivation for the uplands and mechanized post-harvest and farmhouse operations, and/or motorized cultivation in the lowlands especially for rice growing
- (ii) the development and extension of high yielding and diversified plant material (groundnut, millet, sorghum, rice, maize, cotton, cowpea, sugarcane)
- (iii) the introduction of phyto-sanitary methods
- (iv) irrigation in the lowlands which is still on a very reduced scale (less than 100,000 ha out of 2,000,000 ha of flooded or

Fig.1: INTEGRATED RESEARCH SYSTEM IN A DEVELOPMENT PROCESS



irrigated area in Senegal under crops). In every case, water from surface flows is used (mainly river floods).

The catastrophic cycle of present drought calls for the intensification of research on irrigation of the upland areas with ground water.

The basic objectives of research are:

- (i) The maintenance and improvement of land
- (ii) Self-sufficiency in food
- (iii) The development of continuous cultivation (because fallow is progressively disappearing)
- (iv) The growing of crops as a pure stand because the short rainy season is badly adapted to the complex operations associated with mixed cropping
- (v) Integration of cattle into mixed farming
- (vi) Better use of labor (product increase and labor organization)
- (vii) Research on regional agricultural productivities
- (viii) Achievement of national production targets.

New Production Systems and Their Transfer to The Rural Sector

Thus the change in the traditional agricultural systems, which was necessary both technically and politically, was made possible and put into effect on the basis of new technical proposal within the framework of an integrated system of research-development. The pattern is described here by a double approach along two converging lines, the stages of this approach can be summed up as follows:

1. Technological approach: formulation, testing, evaluation of technical cropping and production systems, at the stations and experimental sites, and later on test-farmers' fields. It is indeed necessary, on one hand, to verify whether the elementary innovations are coherent and adapted to combination and, on the other hand, to assess their value and usefulness at the farm level particularly in the context of the national objectives and policies.

This approach is adopted both for physical patterns at several sites in the country and also for mathematical models.

In Senegal, it was possible with this approach to suggest a range

of farm type-patterns for different areas, for farms with sizes varying from 3 ha (two rice crops by year) to 15 ha (rain-fed crops) and with the following economics:

- gross annual product : equivalent to \$ 20,000 to 28,000
- gross monetary margin: \$ 10,000 to 20,000
- margin per worker : \$ 2,000 to 3,600

At the same time, these type patterns give an idea of the agricultural potentialities of the areas in which they are applied; these potentialities are one of the essential bases of planning.

We must point out here how particularly interesting it is to correlate or identify this technological approach to the main agricultural conditions of a country or of a zone so that a production system suitable to them may be identified and its potentialities determined.

This determination of farm type-patterns was recently followed in Senegal by experiments at the larger level of the landscape or production units (soils, irrigated rice-growing areas) studies on a watershed basis are under study. These experiments are expected to result in development patterns.

2. Socio-economic approach to existing production structures, including more particularly the characterization, structures and typology of the farms; the study of labor and its organization; the internal and external farm relations, and the factors of slowing down and short-term and institutional freezing, etc.

This approach is carried out in Senegal at two levels:

- a) At the farm level, with sophisticated regular studies on the farm, its consistency, constraints, labor, economic analysis including the analysis of input use.

By this study the identification and categorization of the criteria and characteristics, as well as an extensive knowledge of the basic organization of the Senegalese farm are possible.

- b) At the landscape or production unit level, with sample surveys according to methods and criteria determined at the preceding level.

By this study, a farm typology can be obtained which will provide the basis of farm management methods for extension; but this is possible only if the typology is judiciously formulated from criteria related to development factors (area, number of workers, equipment, draught animals, etc.).

3. A comparison of the technical production systems with the existing socio-economic structures resulting in socio-economic systems. This is an essential step. It has been for a long time the fundamental gap in the relations between research and extension.

It seems that it is principally on this aspect that efforts must be exerted.

Briefly, the point is to make the farmers adopt or correct or call into question, within the framework of a well concerted action of the researchers and extension officers, valuable technical systems but which must be adapted to the means, structures and mental habit of the community concerned.

Here again, two levels are possible:

- a) The farm level. The innovation package, the new systems proposed to the farmers (the IRAT test-farmers in Senegal - about one hundred distributed throughout the area) who use them on the whole on a part of their farm and, by a feed-back process, show to researchers the difficulties and incoherence and consequently the new adaptation or research ways.
- b) The socio-economic unit. The systems selected at the test-farmer level are considered as being likely to be extended and proposed to ordinary farmers but always within an experimental framework. They are aimed at replacing the farmers in their actual socio-economic environment, determining the external factors affecting speed of adoption and controlling and leading the extension and input supplying structures of the rural sector.

Taking into account these conditions in Senegal, the socio-economic units selected for experimenting the new production patterns were the co-operatives, the basic structure of agricultural development in Senegal.

In 1968, two experimental units were established which consisted of 150 to 200 farms each, having a total population of 4,200 inhabitants distributed over 12,000 hectares (7,500 cultivated).

After 5 years of operation, many useful lessons could be drawn from this experience in the field of research and extension:

- (i) Introduction of ox-draught cultivation in 50 percent of the farms (+ 5 ha);
- (ii) adaptation of equipment advices to all the farm categories;
- (iii) adoption of cropping systems with 4 year rotations of the type

cereals - groundnut (+ cotton) - cereals - groundnut. The basal dressing of phosphate and maintenance of fertility is essential. Ploughing in of straw and farmyard manure (oxen) helps with building soil fertility. There is also a possibility of integration of cattle into mixed farming through drought-oxen, diversification of crop production : cotton, maize, tobacco, introduction of mechanical post-harvest operations, and reforestation.

These adopted innovations cause a change in the economic results of the farms concerned.

Thus, from hand cultivation to semi-intensive ox-draught cultivation on 45 percent of the farm, the data per worker are as follows:

- (i) The total production value rose from \$ 800 to 2,600
- (ii) The agricultural income increased from \$ 720 to 1,960
- (iii) The net monetary margin rose from \$ 350 to 1,480

There is another important point; it can be seen that the farmer had considered the highest possible increase in his production:

- The inter-annual income stability (preference for production or systems not very sensitive to climatic risks but suited to production ensured to be marketed).
- Staggered monetary resources through the year which are made possible, by vegetable crops, animal husbandry, etc.

In fact, the attractive character of the innovations caused deeper changes in the structures and farmer's mental habit, some of which are listed below:

1. A change in the nature and quality of work and exchange of work in the sub-farms of the same farm which can be seen, more particularly, in a better common use of the production machinery and some liberalization of the women status in regard to field work,
2. An awareness of the possibilities of the co-operative effort and acceptance of its rules and limitations and at the same time questioning of some traditional authorities and appearances of new leaders,
3. An attempt to improve life conditions (house, rural water supply), the state of knowledge (alphabetization) and health standard,

4. A possible land redistribution called for by the requirement of a new technology and changes in the agricultural systems,
5. Open discussion on some institutions : development agencies, marketing organization, price and credit policy, land tenure, etc.

It must be noted here that the three stages of the above approach were described separately for the sake of this statement but are in fact carried out simultaneously; one of the main IRAT ideas is that the analysis of the existing production structures assumes its actual value only in the evolutive dynamics of a rural sector made unstable by a new technology, the trends of the movement produced being more important to be known than a fixed situation in an old equilibrium.

Experimental Development

The action of experimental development carried out in the experiment units showed, if needed, the close relationship between the agricultural systems and the socio-economic environment of the farms.

More particularly, it identified and indicated the main retarding and speeding-up factors of agricultural development and all this at the micro-region level, and made it possible to know the attitudes and opinions of the farmers about their possible ways of development.

On the basis of the collected information about the inter-relationships of the endogenous variables (internal to the farm), production system and exogenous variables (activity systems and rural structures), it is possible to propose (to facilitate the guidance of agricultural production, for example) some change or 'manipulation' of the exogenous variables.

In other words, with such a knowledge of the mechanisms of rural activities the elements or bases of an agricultural development policy can be proposed.

After the first five years of the experiment unit operation, a series of political measures have been suggested to the Senegal Government, for example:

- price fixing, before the season, at calculated levels which take into account the development objectives and the compared production conditions (more particularly pricing of cereals and re-adjustment of cotton and groundnut prices),
- incentives to the adoption of post-harvest operations (threshing, stockage) for cereals,

- organization of a network for marketing cereals and meat,
- providing subsidy for the purchase of machinery, fertilizer subsidies and adaptation of the credit term to the type of machinery,
- education of young adults more particularly with a view to facilitating co-operative management,
- test operations of land improvement at the rural group or community level.

Besides these measures, it is suggested that research may be conducted into the methodology of close communication between research organizations and extension organizations on the spot with a view to studying and solving the problem of development.

It seems that this communication must be greatly favored by the fact that the extension organizations and bodies need information more and consult research not at the elementary research level, but in terms of production systems and farming structures also.

The experiment carried out in Senegal in this field is perhaps worthy to be extended to other countries and under other conditions.